Risk factors for colostomy in military colorectal trauma: A review of 867 patients

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Background. *Limited data exist examining the use of fecal diversion in combatants from modern armed conflicts. Characterization of factors leading to colostomy creation is an initial step toward optimizing and individualizing combat casualty care.*
Methods. *A retrospective review of the US Department of Defense Trauma Registry database was performed for all US and coalition troops with colorectal injuries sustained during combat operations in Iraq and Afghanistan over 8 years. Colostomy rate, anatomic injury location, mechanism of injury, demographic data, and initial physiologic parameters were examined. Univariate and multivariate analyses were conducted.*
Results. *We identified 867 coalition military personnel with colorectal injuries. The overall colostomy rate was 37%. Rectal injuries had the highest diversion rate (56%), followed by left-sided (41%) and right-sided (20%) locations (P < .0001). Those with gunshot wounds (GSW) underwent diversion more often than blast injuries (43% vs 31% respectively, P < .0008). Injury Severity Score ≥ 16 (41% vs 30%; P = .0018) and damage control surgery (DCS; 48.2% vs 31.4%; P < .0001) were associated with higher diversion rates. On multivariate analysis, significant predictors for colostomy creation were injury location: Rectal versus left colon (odds ratio [OR], 2.2), rectal versus right colon (OR, 7.5), left versus right colon (OR, 3.4), GSW (OR, 2.0), ISS ≥ 16 (OR, 1.7), and DCS (OR, 1.6).*
Conclusion. *In this exploratory study of 320 combat-related colostomies, distal colon and rectal injuries continue to be diverted at higher rates independent of other comorbidities. Additional outcomes-directed research is needed to determine whether such operative management is beneficial in all patients. (Surgery 2014;155:1052-61.)*

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THE MANAGEMENT OF MULTISYSTEM TRAUMA PATIENTS from Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF) remains highly challenging. The battlefield injured sustain high-velocity gunshot wounds (GSW) and blast injuries to both trunk and extremities, and surgeons often face constrained resources, long-distance evacuations of wounded across multiple continents, and provision of care at multiple treatment facilities by different providers. Although the modern medical literature supports the practice of primary repair of colon and rectal injuries in civilian trauma patients, the management of wartime colon and rectal injuries has primarily consisted of fecal diversion with colostomy.[1-3] Although both our understanding of and initial treatment approach to complex polytrauma patients are improving, the ideal management of colon injuries in modern conflicts remains poorly elucidated.[4]

Colon trauma, once considered a universally fatal injury, has seen a significant decline in mortality over the last 70 years due to the advancement of antibiotics, blood component resuscitation, and the expeditious repair of injuries to prevent fecal contamination.[5] In the most severely injured

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patients, damage control surgery (DCS) with emphasis on stopping life-threatening hemorrhage, controlling enteric spillage, and focused, expeditious patient resuscitation, has been successfully applied in the civilian and military trauma settings.[6-9] While DCS undoubtedly saves lives when judicially applied, how the well-established practice of fecal diversion relates to the newer wartime damage control techniques remains uncertain.[4,10-14]

Both primary colonic repair or resection with anastomosis carry increased morbidity in the wartime and civilian trauma setting, particularly when combined with DCS techniques.[10,14-17] An initial step toward improving combat casualty care is understanding the wound and patient factors that correlate with colostomy creation. Ultimately, the aim is to optimize combat casualty care by minimizing potentially unnecessary ostomies without needlessly incurring more risk for the injured soldier. The current study examines the risk factors for colostomy creation in military colorectal trauma patients, with the goal of characterizing the factors that prompt surgeons to favor fecal diversion.

METHODS

The Joint Surgical Transcolonic Injury or Ostomy Multi-Theater Assessment (J-STOMA) project is an ongoing initiative to examine outcomes from OIF and OEF specific to colorectal injury. Both J-STOMA and the current study were approved by the Institutional Review Board for the US Army Medical Research and Materiel Command and are conducted within the US Army Institute of Surgical Research (USAISR). The Department of Defense developed the Joint Trauma System as a systematic, integrated approach to organize and coordinate battlefield care.[18] To provide near real-time casualty data collection to combatant and medical commanders, the Joint Trauma System created the Department of Defense Trauma Registry (DoDTR), formerly known as the Joint Theater Trauma Registry. The DoDTR is maintained by the USAISR and electronically documents patient demographics, injury mechanism, diagnosis and treatment, and outcome of injuries sustained by US/non-US military and US/non-US civilian personnel in wartime from the point of wounding to final disposition. Trained research nurses enter data at both forward deployed locations and major referral medical centers.[19]

For the current study, the DoDTR database was queried for all colon and/or rectal injuries using ICD-9 diagnosis codes (863.4x, 863.5x) and military Abbreviated Injury Scale (AIS) codes with a severity modifier of >2. The Injury Severity Score (ISS) summarizes the severity of injury across 6 body regions using the anatomically focused 2005 Abbreviated Injury Scores (AIS) as its basis. A severely injured body region (AIS BRX > 2) is considered any region with score of >2. Dates of inclusion were from January 2003 to March 2011. The study population was composed of all coalition military personnel to include US Service members, NATO military personnel, and host nation (non-NATO) military forces (n = 867). The latter group included Iraqi and Afghan National Armies, police, and security forces. To maintain a uniform dataset, patients who sustained colon injuries who were managed with an ileostomy were excluded from analysis (n = 34). Civilian casualties, prisoners of war, and patients who had incomplete documentation of colorectal injury-missing either the ICD-9 or AIS code were excluded, as were anal and complex pelvic-perineal injuries without documented trauma to the colon or rectum (n = 76). Those killed in action or dead on arrival to medical treatment facility are not included in the DoDTR. For the purposes of this study, injury locations were defined as right colon (cecum to splenic flexure), left colon (splenic flexure to rectosigmoid junction), and rectum. Whenever possible, specific anatomic locations of colorectal injuries were gleaned from the ICD-9 codes and narrative summaries contained in the DoDTR. Patients with multiple colorectal wounds were categorized according to the distal-most injured region. Extracted data included patient demographics, initial physiologic parameters and laboratory values, diagnosis and treatment codes, and military treatment facility level using standard NATO nomenclature. Because of the complex interplay in surgical decision making and the frequent association between lower gastrointestinal tract trauma, complex pelvic fractures, and lower extremity amputations, the incidences of the latter 2 injuries were examined and reported as separate risk factors.

Statistical analysis compared the likelihood of colostomy across various risk factors within our cohort of injured subjects. Data were analyzed using SAS v 9.2 (SAS Institute, Cary, NC) with partition analysis performed using JMP v 9.0. Continuous variables were presented as mean values ± standard deviation and analyzed by the Student t test. Discrete variables were compared using Chi-square or Fishers exact test, as appropriate, and summarized with percentages. Factors that were significantly associated with colostomies on univariate analysis ($P < .05$) were then incorporated in a multiple logistic regression model. Regression analysis was performed for all injuries, regardless of injury mechanism, followed by a separate subset analysis for injuries sustained with either a blast or GSW mechanism of injury. All factors that were not significant were removed using backward elimination until there was a final model containing only factors with $P < .10$. Odds ratios (OR) are reported with 95% confidence intervals. An optimizing recursive partitioning algorithm in JMP v 9.0, which segregates factors based on their contribution to prediction of colostomy, was used to determine probability of colostomy.[20] All of the factors found significant in multivariate analyses were used in the partitioning algorithm.

RESULTS

Demographics and initial presentation. We identified 867 military personnel with battle-related colon or rectal injuries (Table I). Five hundred ninety-one patients (68%) sustained colorectal trauma in support of combat operations in Iraq, whereas 276 (32%) sustained injuries while serving in Afghanistan. The mean age of patients was 26.1 ± 6.6 years. US military personnel constituted 495 (57%) of the cohort. Non-American NATO personnel comprised 51 (6%) of the wounded and non-NATO personnel comprised 321 (37%) of wounded.

Patients with colorectal trauma were typically seriously injured. The mean ISS for the cohort was 22.8 ± 13.1. For reference, casualties with an ISS of ≥16 are generally considered seriously injured; a total of 566 military personnel (65%) met this criterion. Patients had an initial base deficit of 3.5 ± 7.0 mEq/L, and required a total blood product usage of 7.7 ± 13.9 units (U) during initial stabilization. One hundred sixty-nine patients (20%) underwent massive transfusion (>12 U), although these data were available for only 847 patients within the cohort. The ICD-9 code for repeat laparotomy (54.12) served as an indicator for personnel who underwent initial DCS techniques. A total of 284 (32.8%) patients underwent repeat laparotomy. Seven hundred eighty-one patients initially received treatment in a Role II military treatment facility versus 86 patients who received initial care in a Role III facility. There was no statistical difference in the repeat laparotomy rates between patients undergoing initial surgical treatment at Role II versus III facilities (33% vs 30%, respectively; $P = .28$). The average length of stay in theater for US and other NATO troops was 5.5 ± 10.6 days postinjury.

Injury characteristics. Seven hundred seventy-eight patients had a documented mechanism of injury. GSWs were the most prevalent mechanism of colorectal injury, occurring in 387 (44.6%) patients. Blasts or explosives (such as from improvised explosive devices [IEDs]) resulted in 354 injuries (41%); other mechanisms such as miscellaneous blunt force, motor vehicle crash, and fall from heights caused the remaining injuries.

The specific anatomic location of the colorectal injury could be determined from the DoDTR data in 694 patients. Right-sided colon injuries occurred in 247 patients, whereas left colon and rectal injuries were documented in 218 and 229 patients, respectively. Traumatic amputations of ≥1 lower extremity above the ankle occurred in 106 patients (12%), and concurrent pelvic fractures were reported in 215 patients (25%).

Risk factors for colostomy creation. Three hundred twenty patients (37%) underwent fecal diversion with colostomy. The colostomy rates per year ranged widely between 17% and 42%, although there was no trend observed with time ($P = .85$; Fig 1). The colostomy rate for troops in OIF was 39% versus 32% in OEF ($P = .05$). US and Non-NATO forces were both diverted at higher rates (39% and 36%, respectively) than non-US, NATO forces (22%; $P = .04$).

As shown in Table II, several risk factors were identified on univariate analysis as being strongly associated with colostomy creation after military colorectal trauma. Overall injury severity as represented by ISS was analyzed as both a continuous and discrete variable and found to correlate with higher colostomy rates. Patients with an ISS of ≥16 underwent fecal diversion more often than those less injured (41% vs 30%, respectively; $P = .002$). Among those who did not receive a colostomy, the mean ISS was 21.8 ± 12.8, compared with 24.2 ± 11.48 for patients treated with fecal diversion ($P = .01$). Personnel with GSWs had the highest diversion rate at 43% compared with those sustaining blast injuries (31%) or other mechanisms (19%; $P < .001$). Patients who had a colostomy had a statistically higher blood transfusion requirement compared with those without fecal diversion (8.9 vs 6.9 U, respectively; $P = .048$). However, massive transfusion, defined as ≥12 U of product administered, had no significant association with ostomy rate (43% for >12 U compared with 35% for ≤12 U; $P = .06$). Presenting base deficit did not differ between the 2 groups (2.82 colostomy vs 3.95 no colostomy; $P = .08$).

Table I. Demographic data and initial presentation of 867 combat-related colon and rectal injured personnel

Variable	n (%) or mean ± SD
Age (y)	26.1 ± 6.6
Patient category	
US Forces	495 (57.1)
Army	365 (42.1)
Air Force	6 (0.7)
Navy	12 (1.4)
Marine	112 (12.9)
NATO	51 (5.9)
Non-NATO	321 (37.0)
Military operation	
Operation Iraqi Freedom	591 (68.2)
Operation Enduring Freedom	276 (31.8)
Mechanism of injury	
Gunshot wound	387 (44.6)
Blast	354 (40.8)
Other*	37 (4.3)
Not documented	89 (10.3)
Injury Severity Score	22.8 ± 13.1
Initial base deficit	3.5 ± 7
Blood products (U)	7.7 ± 13.9
Massive transfusion (>12 U)†	169 (20)
Post-injury time in theater (d)	5.1 ± 10.6
Location of injury‡	
Right colon	247 (28.4)
Left colon	218 (25.1)
Rectum	229 (26.4)
NOS	173 (20)
Associated injuries	
Repeat laparotomy	284 (32.8)
Traumatic leg amputation	106 (12.2)
Pelvic fracture	215 (24.8)

*Includes falls, motor vehicle collisions, and stab wounds.
†Data missing for 20 patients.
‡Categorized by distal-most colon or rectal injury.
NOS, Not otherwise specified.

Not surprisingly, distal colon injuries were diverted at higher rates compared with proximal injuries. Right colon injuries occurred in 247 personnel with a colostomy rate of 19%, whereas left colon injuries occurred in 218 personnel with a colostomy rate of 41%. Rectal injuries (n = 229) were diverted at the highest rate of 56% ($P <$ .001 relative to colon injury). AIS scores by body region were analyzed to determine an association with fecal diversion. Patients with more severe abdominal trauma (AIS BR4 [abdomen] > 2) underwent diversion 41% of the time compared with 30% for patients with AIS BR4 ≤ 2 (P = .001). Those with severe extremity injuries (AIS BR5 > 2) also underwent diversion more often (43% vs 31%; $P < .001$). Injury to other body regions was not associated with an increased stoma rate. Personnel who sustained pelvic fractures and/or leg amputations in addition to colorectal injuries had colostomies at higher rates. Those who sustained pelvic fractures underwent diversion 45% of the time (compared with 34% without pelvic fracture; $P = .004$). Likewise, personnel sustaining traumatic leg amputations more frequently underwent fecal diversion (46% vs 36%; $P = .03$).

The ICD-9 procedure code for repeat laparotomy, used in the current study to indicate DCS techniques, strongly correlated with colostomy creation. Patients undergoing multiple laparotomies were diverted at a rate of 48% compared with 31% in those who underwent a single laparotomy ($P < .001$). There was no difference in the injury severity between those who received DCS versus single laparotomy (ISS 23.5 ± 13.6 vs 22.4 ± 12.9; $P = .28$).

On multivariate analysis, both left-sided colon and rectal injuries were significant independent risk factors for fecal diversion compared with right-sided injuries (left versus right colon injury: OR, 3.34; 95% CI, 2.15–5.35; $P < .001$; rectum versus right colon: OR, 7.46; 95% CI, 5.4–15.38; $P <$ .001). As shown in Fig 2 and Table III, other correlated factors included patients with higher injury burdens (ISS ≥ 16: OR, 1.66; 95% CI, 1.12–2.46; $P = .01$), repeat laparotomy (OR, 1.56; 95% CI, 1.06–2.29; $P = .02$), and GSW mechanism (OR, 2.01; 95% CI, 1.37–2.96; $P < .001$).

To determine whether different features influenced surgical decision making when treating patients injured by either gunshot or an IED, subset multivariate analysis was performed on the basis of mechanism of injury. Interestingly, regardless of GSW or blast injury, the same factors persistently correlated with fecal diversion, namely, distal colon injury (left versus right colon injury and rectal versus left colon injury) and severe intra-abdominal injury (Table III). Left colon injuries compared with right colon injuries from GSW carried a slightly higher risk of diversion (OR, 3.69; 95% CI, 2.0–6.85; $P < .001$) compared with the same injury from a blast (OR, 3.31; 95% CI, 1.57–6.99; $P = .001$). Rectal injuries compared with left colon injuries displayed similar ORs for diversion based on mechanism of injury; GSW (OR, 2.39; 95% CI, 1.26–4.54; $P < .001$) versus blast (OR, 2.26; 95% CI, 1.24–4.13; $P < .001$). Severe intra-abdominal injury (AIS BR4 > 2) was an independent predictor of diversion with similar ORs based on mechanism (GSW: OR, 1.63; 95% CI, 1.26–2.11; $P < .001$ versus blast: OR, 1.37; 95% CI, 1.05–1.79; $P = .02$). Although it approached

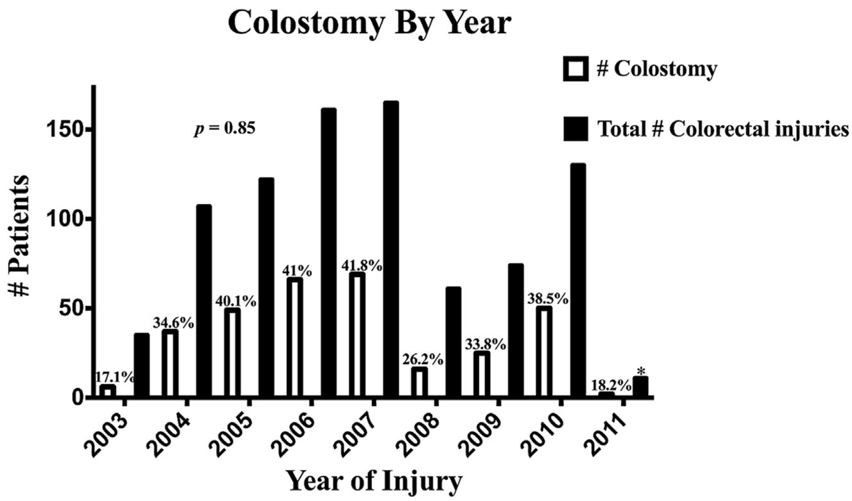

Fig 1. Colostomy creation by year. Percent colostomy is displayed above the total number of colostomies performed in a given year. *Analysis of colostomy rate in 2011 is through March 2011.

significance, the total number of days in theater of conflict did not predict fecal diversion (GSW: OR, 1.022; 95% CI, 0.99–1.05; $P = .08$; blast: OR, 1.033; 95% CI, 0.99–1.07; $P = .08$).

Risk factor partitioning. Risk factor partitioning determined that injury location was the strongest predictor for colostomy creation, with rectal injury location found to be the largest risk factor for colostomy, followed by injury to the left colon then the right colon. DCS techniques were the second most important factor in predicting colostomy. Mechanism of injury, specifically GSW versus other, which includes blast mechanism, was the third most significant factor followed by ISS of ≥16. Table IV breaks down the partitions determined in JMP.

DISCUSSION

This retrospective study of 867 patients with military colorectal trauma comprises the largest reported series examining the factors influencing colostomy placement after modern battlefield trauma. Despite civilian data indicating that anatomic location of the injury should not influence the decision for diversion, military surgeons continue to perform colostomies based largely on this distinction, as evidenced by diversion rates of 19%, 41%, and 56% for right, left and rectal injuries, respectively.[21] Distal colon and rectal injuries were diverted at higher rates than more proximal injuries independent of other comorbidities, the need for massive transfusion, physiologic status, or mechanism of injury. Other significant predictors of colostomy creation included ISS of ≥16, DCS techniques, and gunshot wounding. Interestingly, DCS and severe injury were nearly equivalent independent predictors for stoma placement.

Out of 694 patients with a documented injury location, distal injuries had higher rates of diversion. Although previous studies have excluded rectal injuries from their series, we included rectal injuries to fully characterize colostomy risk factors.[14] Injury location was found to dominate other risk factors frequently associated with fecal diversion. Additionally, injury location correlated strongly with colostomy creation even when controlling for mechanism of injury (eg, GSW versus blast from an IED). For instance, a patient with a GSW to the right colon injury who presented with an ISS of ≥16 and required damage control surgery (and thus had 3 risk factors for colostomy) had a nearly equivalent probability of a receiving a stoma as a less injured patient with a rectal injury from a blast who underwent a single laparotomy (0.34 vs 0.33, respectively), despite the latter patient having only a single independent predictor. Surgeons' use of injury location in the current series as a determinant for fecal diversion starkly contrasts with established trends in the literature for civilian trauma, raising the question whether military colorectal trauma fundamentally differs from equivalent civilian injuries.[21,22] There are several possible explanations. Blast or high-velocity GSWs routinely yield more destructive large bowel injuries, and concomitant injuries might compel surgeons to perform the most expeditious operative intervention. Alternatively, the US military medical system may have an 'institutional bias' toward greater use of fecal diversion, even for otherwise straightforward colon injuries.

Table II. Comparison between personnel who underwent colostomy (n = 320) and those in whom fecal diversion was not performed (n = 547)

Risk factor	*Colostomy,* n *(%)*	*No colostomy,* n *(%)*	P *value*
Age (mean ± SD)	25.2 ± 6.6	26.1 ± 6.8	.63
ISS (mean ± SD)	24.2 ± 12.4	21.9 ± 13.5	.01
Initial base deficit (mean ± SD)	2.82 ± 5.9	3.95 ± 7.6	.079
Total blood, U (mean ± SD)	8.9 ± 15.72	6.9 ± 12.6	.04
Days in theater (mean ± SD)	6.2 ± 10.4	4.47 ± 10.9	.02
Injury location			
Right colon	48 (15)	199 (36.4)	
Left colon	89 (27.8)	129 (23.6)	<.001
Rectum	128 (40)	101 (18.5)	
NOS	55 (17.1)	118 (21.5)	
Patient category			
US Forces	195 (60.9)	300 (54.8)	
NATO	11 (3.4)	40 (7.3)	.03
Non-NATO	114 (35.6)	207 (37.8)	
Theater of operation			.05
Operation Iraqi Freedom	231 (72.1)	360 (65.8)	
Operation Enduring Freedom	89 (27.8)	187 (34.2)	
Mechanism of injury			
Blast	109 (30.9)	245 (44.8)	
Gunshot wound	165 (42.6)	222 (40.6)	<.001
Other	7 (18.9)	30 (5.5)	
Level of initial surgical care			.77
Role II	287 (89.7)	494 (90.3)	
Role III	33 (10.3)	53 (9.7)	
Severe injury (ISS ≥ 16)			.002
Yes	230 (71.9)	336 (61.4)	
No	90 (28.1)	211 (38.6)	
Leg amputation			.03
Yes	49 (15.3)	57 (10.4)	
No	271 (84.7)	490 (89.6)	
Pelvic fracture			.004
Yes	97 (30.3)	118 (21.6)	
No	223 (69.7)	429 (78.4)	
Repeat laparotomy			<.001
Yes	137 (42.8)	147 (26.8)	
No	183 (57.2)	400 (73.1)	
Massive transfusion (>12 U)*			.06
Yes	73 (23)	96 (18.1)	
No	244 (77)	434 (81.9)	
Max AIS BR1—head/neck			.47
BR1 > 2	28 (8.8)	56 (10.2)	
BR1 ≤ 2	292 (91.2)	491 (89.8)	
Max AIS BR2—face			.90
BR2 > 2	1 (0.31)	2 (0.37)	
BR2 ≤ 2	319 (99.7)	545 (99.6)	
Max AIS BR3—chest			.32
BR3 > 2	60 (18.8)	118 (21.6)	
BR3 ≤ 2	260 (81.2)	429 (78.4)	
Max AIS BR4—abdomen			.001
BR4 > 2	229 (71.6)	331 (60.5)	
BR2 ≤ 2	91 (28.4)	216 (39.5)	
Max AIS BR5—extremity			.003
BR5 > 2	179 (55.9)	236 (43.1)	
BR2 ≤ 2	141 (44.1)	311 (56.9)	

(*continued*)

Table II. (*continued*)

Risk factor	*Colostomy,* n *(%)*	*No colostomy,* n *(%)*	P *value*
Max AIS BR6—external			.93
BR2 > 2	20 (6.3)	35 (6.4)	
BR2 ≤ 2	300 (93.7)	512 (93.6)	

*Data missing from 20 patients with massive transfusions (>12 U;) percentages represent (n = 317, colostomy; n = 530, no colostomy).
AIS, Abbreviated Injury score; *ISS*, Injury Severity Score; *NOS*, not otherwise specified.

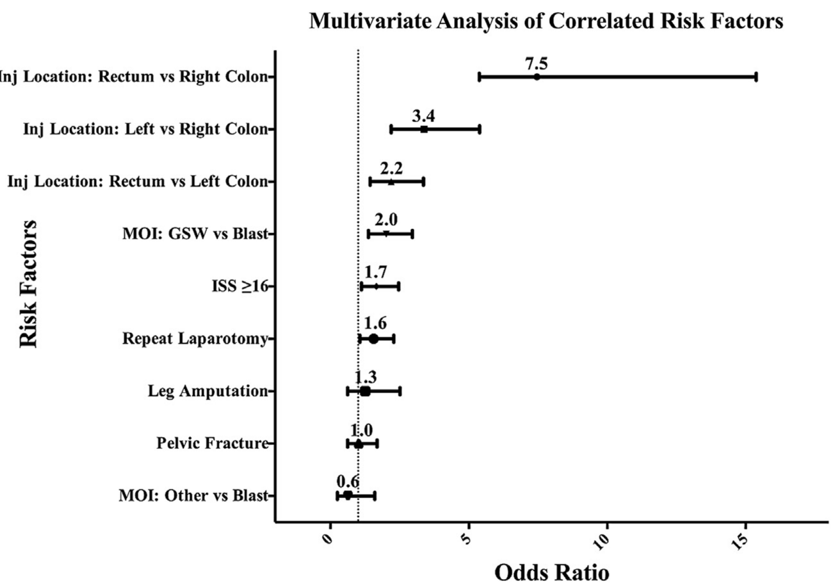

Fig 2. Predictors for colostomy creation on multivariate analysis. *Inj*, Injury; *ISS*, Injury Severity Score; *MOI*, mechanism of injury.

Diversion may seem "safer" than attempting an anastomosis, especially in the context of having a critically injured soldier who will be transported across multiple continents under the care of numerous providers. Irrespective of the reason, it should be noted that despite the significantly higher colostomy creation rate in the current series, the majority of all combat colorectal wounds (63%) were initially managed without fecal diversion. It should be noted that this is in stark contrast with previous conflicts, where diversion approached nearly 100%.[2,3] In this context, the current study documents the evolving trends in the contemporary management of wartime colorectal injuries and will serve as a benchmark for surgeons in future armed conflicts.

Initial reports of wounding patterns from OIF and OEF found blast injuries were the most common mechanism of injury. However, when focused specifically on colorectal trauma, GSWs are the predominant wounding modality.[4,11-14,23,24] In the current study, GSW was found to be an independent risk factor for fecal diversion on multivariate analysis. Conversely, blast injury was not found to be an independent risk factor for colostomy. The typical blast wound seen in conjunction with colorectal injuries is from a ground-level IED where the blast effect of low-velocity fragments causes lower extremity injuries and pelvic fractures. The pelvis along with modern body armor plates may bear the brunt of the damage, resulting in less destruction to the abdominal contents. The cavitation and energy transfer imparted by high-velocity military rifle rounds produces devitalized tissue adjacent to the primary injury and endothelial damage within the blood vessels.

The last decade's experiences in Iraq and Afghanistan have highlighted the importance of damage control resuscitation and surgery. Not surprisingly, the repeat or "second-look" laparotomy is frequently utilized in the operative care of combatants. There are increasing data to suggest that colon resections and anastomoses performed after DCS carry greater leak and abscess rates compared with single laparotomy.[15-17] Weinberg et al[15] demonstrated that primary repairs as well

Table III. Multivariate analysis for colostomy based on mechanism of injury

Risk factor	Gunshot wound			Blast injury		
	OR	95% CI	P value	OR	95% CI	P value
Inj Loc: L vs R	3.69	2.0–6.85	<.001	3.31	1.572–6.99	.001
Inj Loc: Rect vs L	2.39	1.263–4.54	.007	2.26	1.241–4.130	.007
Max AIS BR4 (Abd Inj)	1.63	1.26–2.11	<.001	1.37	1.049–1.79	.02

AIS, Abbreviated Injury Score; *Abd*, abdominal; *Inj*, injury; *L*, left colon; *Loc*, location; *R*, right colon; *Rect*, rectum.

Table IV. Risk factor partitioning for colostomy placement after military colon or rectal trauma

Injury location	Operative approach	Mechanism of injury	ISS	Probability of colostomy	n
Rectum	DCS	GSW	ISS ≥ 16	0.74	31/42
L colon	DCS	GSW	ISS ≥ 16	0.72	21/29
Rectum	DCS	Other	ISS ≥ 16	0.67	22/33
Rectum	DCS	GSW	ISS < 16	0.63	5/8
Rectum	SL	GSW	ISS ≥ 16	0.6	31/52
L colon	DCS	GSW	ISS ≥ 16	0.51	21/41
L colon	DCS	Other	ISS < 16	0.5	5/10
L colon	DCS	Other	ISS ≥ 16	0.47	15/34
Rectum	SL	GSW	ISS < 16	0.41	15/37
Rectum	DCS	Other	ISS < 16	0.4	2/5
L colon	DCS	GSW	ISS < 16	0.4	6/15
R colon	DCS	GSW	ISS < 16	0.4	8/20
Rectum	SL	Other	ISS ≥ 16	0.38	30/79
R colon	DCS	GSW	ISS ≥ 16	0.34	16/47
Rectum	SL	Other	ISS < 16	0.33	11/33
L colon	SL	GSW	ISS < 16	0.31	14/45
L colon	SL	Other	ISS ≥ 16	0.31	18/58
R colon	SL	GSW	ISS ≥ 16	0.23	14/62
L colon	SL	Other	ISS < 16	0.2	5/25
R colon	DCS	Other	ISS < 16	0.15	2/13
R colon	SL	GSW	ISS < 16	0.15	6/41
R colon	DCS	Other	ISS ≥ 16	0.11	3/28

DCS, Damage control surgery; *GSW*, gunshot wound; *ISS*, Injury Severity Score; *L*, left; *Other*, includes blast mechanisms; *R*, right; *SL*, single laparotomy.

as resections with anastomoses in the setting of damage control techniques carried higher rates of complications, particularly leak and abscesses, compared with patients who underwent single laparotomy.[15] Other authors have shown that the leak rate in the setting of resection and anastomosis was over 4 times greater in patients managed with an open abdomen compared with single laparotomy, whereas results from the recent Western Trauma Association's multicenter trial showed a similar 4-fold risk for leak in patients whose abdomen was left open of >5 days.[16,17] Notably, a large portion of the 284 patients in the current study treated with DCS techniques likely met this criterion. Given these findings and the previously reported 31% mortality associated with anastomotic leak in military trauma patients, there is considerable risk in performing primary repair after damage control laparotomy.[10] Thus, it is not surprising that DCS was an independent risk factor for colostomy creation, especially because patients who underwent single laparotomy had similar degrees of injury compared with the DCS cohort. However, it remains unclear whether DCS is overutilized in general, and how to determine which polytrauma patients with colorectal injuries truly require repeated laparotomies.[25,26] Although conjecture, in the critically ill patient with a straightforward colon injury, perhaps the better treatment option is to perform colostomy at the initial operation to avoid the morbidity associated with repeat laparotomies.

Contrary to civilian studies, massive transfusion was not associated with higher colostomy utilization, with massive transfusion rates of 23% and 18% for diversion versus non-diversion, respectively.[1] This may reflect trends toward increased employment of DCS techniques and directed product transfusion, increased tourniquet usage, and increased utilization of balanced resuscitation practices with higher fresh frozen plasma: packed red blood cell ratios.[26,27] Our study adds to the literature refuting blood transfusion requirements in isolation as an indicator for colostomy creation, particularly in the era of more sophisticated, balanced damage control resuscitation.

The current study has several limitations. The retrospective study design allows the possibility of surgeon selection bias in deciding which patients received colostomies. Although many physiologic and anatomic injury features were available for analysis, other factors such as environmental concerns, enemy activity, surgeon training or experience, volume of casualties, and time to evacuation to higher level of care were not captured. Despite the tremendous improvements in battlefield data collection, there remains relatively limited or incomplete documentation of all combat wounds, and clinical follow-up, particularly of injured non-NATO allied personnel, is limited. Perhaps the most significant limitation is the lack of outcomes data related to colostomy creation and subsequent morbidity. To present outcomes data to include postoperative morbidity, ostomy reversal rates, and complication rates, as well as overall quality-of-life outcomes requires independent, dedicated review of each patient's chart which is outside the scope of this study. Although the present study provides useful insight into current operative decision making, forthcoming longitudinal studies incorporating clinical outcomes are required to further elucidate the ideal management of combat colorectal trauma.

Given the significant differences between civilian and military colon injuries, it may be inappropriate to apply the trends in civilian colorectal trauma management to the military patient. This study provides a snapshot of the contemporary surgical management of combat-related colorectal trauma. Anatomic location of the colorectal injury continues to be the dominant factor in deciding whether to create a colostomy. To a lesser extent, DCS techniques influenced fecal diversion rates, as did mechanism of injury and overall injury severity. Going forward, military surgeons should be cognizant of these predictors of fecal diversion, and further study of the complex interaction between DCS and colonic injury is necessary.

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